Oxford Cambridge and RSA

AS Level Chemistry B (Salters)

H033/01 Foundations of chemistry

Tuesday 22 May 2018 – Morning

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry B (Salters) (sent with general stationery)

You may use:
- a scientific or graphical calculator

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **20** pages.

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SECTION A

You are advised to spend no more than 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 What is the correct order of radiation in order of increasing wavelength?

A ultraviolet < visible < infrared

B ultraviolet < infrared < visible

C visible < infrared < ultraviolet

D infrared < visible < ultraviolet

Your answer ☐ **[1]**

2 Which of the following is a cyclic saturated aliphatic compound?

A cyclohexene

B cyclohexane

C benzene

D hexane

Your answer ☐ **[1]**

3 What is **not** a property of hydrogen iodide?

A It reacts with ammonia.

B It is soluble in water.

C It is stable to heat.

D It reacts with sodium hydroxide.

Your answer ☐ **[1]**

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4 What is the correct order of boiling points with the lowest first?

A CH_4 CH_3Cl CH_3OH

B CH_4 CH_3OH CH_3Cl

C CH_3Cl CH_3OH CH_4

D CH_3OH CH_3Cl CH_4

Your answer ☐ **[1]**

5 Which statement about ozone is correct?

A Ozone is a polluting gas in the stratosphere.

B Ozone acts as a sunscreen in the stratosphere.

C There is no ozone in the troposphere.

D Ozone is an isomer of oxygen.

Your answer ☐ **[1]**

6 A company makes a cleaning product and is looking for a 'greener' method of making the product.

Which one of the following would the company consider?

A Finding a reaction with a higher percentage yield.

B Finding a reaction with a higher atom economy.

C Using more organic solvents.

D Using inorganic catalysts rather than enzymes.

Your answer ☐ **[1]**

7 Name the functional group in HCHO.

A aldehyde

B ketone

C alcohol

D carboxylic acid

Your answer ☐ **[1]**

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8 1.0 g of solid carbon dioxide is vaporised.
What volume of gas (in cm^3) is produced at RTP?

A 0.55

B 24

C 550

D 24 000

Your answer ☐ **[1]**

9 What is the percentage of chlorine by mass in magnesium chloride?

A 59%

B 66%

C 74%

D 75%

Your answer ☐ **[1]**

10 Which statement about the reactions of solid halides with concentrated sulfuric acid is correct?

A Chlorides produce HCl as the only gas.

B Bromides produce HBr, Br_2 and H_2S.

C Iodides produce HI, I_2 and SO_2.

D Astatides would be expected to produce HAt only.

Your answer ☐ **[1]**

11 Which statement about electronegativity is correct?

A Electronegativity is the charge on an element's ion.

B If a bond is polar, the two atoms have different electronegativities.

C If a molecule has no dipole, all its atoms have the same electronegativity.

D Electronegativity increases down a group of the Periodic Table.

Your answer ☐ **[1]**

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12 Which substance does **not** have hydrogen bonding between its molecules?

A C_6H_5OH

B CH_3CHO

C CH_3COOH

D C_3H_7OH

Your answer ☐ **[1]**

13 Which statement about the flame colour of lithium is correct?

A It is yellow.

B It is caused by electrons absorbing visible light.

C It is the result of bright lines in lithium's emission spectrum.

D It follows a pattern of colours in Group 1.

Your answer ☐ **[1]**

14 35 cm^3 of a solution has a concentration of 0.125 mol dm^{-3}.
A student calculates the amount (in moles) of solute in this solution.

Which answer is given to the appropriate number of significant figures?

A 4.37×10^{-3}

B 4.375×10^{-3}

C 4.38×10^{-3}

D 4.4×10^{-3}

Your answer ☐ **[1]**

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15 Hydrochloric acid reacts with sodium carbonate as shown in the equation.

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$$

20 cm^3 of 2.0 mol dm^{-3} Na_2CO_3 are added to 20 cm^3 2.0 mol dm^{-3} HCl.

What mass of CO_2 (in g) is produced?

A 0.88

B 1.76

C 22

D 1760

Your answer ☐ **[1]**

16 A sample of gas has a mass of m g and occupies a volume V m^3 at a pressure p Pa and temperature T K.

Which expression is correct for the M_r of the gas?

A mRT/pV

B pV/mRT

C pV/RT

D mRT/npV

Your answer ☐ **[1]**

17 Which statement about carboxylic acids is correct?

A They can be made by oxidising secondary alcohols.

B They react with phenols.

C They do **not** fizz with sodium carbonate solution.

D They form esters when reacted with tertiary alcohols.

Your answer ☐ **[1]**

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18 What is **not** a consequence of hydrogen bonding?

A Water expands on freezing.

B Ethanol is very soluble in water.

C Sodium chloride dissolves in water.

D H_2O has a higher boiling point than H_2S.

Your answer ☐ **[1]**

19 Which statement about a lattice of sodium chloride is correct?

A The ions are the same size.

B The attraction between two sodium ions is greater than the repulsion between two chloride ions.

C Each sodium ion is surrounded by six chloride ions.

D There are more sodium ions than chloride ions.

Your answer ☐ **[1]**

20 Which row is correct?

	Name	**Formula**
A	sodium nitride	Na_3N
B	aluminium sulfate	$Al SO_4$
C	copper(I) oxide	CuO
D	calcium hydroxide	$CaOH_2$

Your answer ☐ **[1]**

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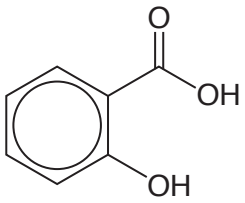
SECTION B

Answer **all** the questions.

21 Aspirin is a medicine that reduces fever and relieves pain.
Some students prepare a sample of aspirin from salicylic acid.



salicylic acid

(a) Before the students start the preparation, they test the salicylic acid with iron(III) chloride.

What colour would they see?

..... **[1]**

(b) The students then make aspirin by warming 6.0 g of salicylic acid with 10 cm^3 of ethanoic anhydride in the presence of concentrated sulfuric acid.

$$\underset{\text{salicylic acid}}{HOOCC_6H_4OH} + \underset{\text{ethanoic anhydride}}{(CH_3CO)_2O} \rightarrow \underset{\text{aspirin}}{HOOCC_6H_4OCOCH_3} + \text{.....}$$

(i) Balance the equation by writing the structural formula of the other product on the dotted line.

[1]

(ii) The density of ethanoic anhydride is 1.1 g cm^{-3}.

Calculate the amount (in moles) of ethanoic anhydride used.

amount of ethanoic anhydride = ... mol **[1]**

(iii) Which is in excess, the salicylic acid or the ethanoic anhydride?

[2]

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(c) The students pour their hot solution into water and aspirin crystallises out as the water cools.

The students then look for a suitable solvent to recrystallise the aspirin.

(i) State the properties of a suitable solvent for recrystallisation.

.....

..... **[1]**

(ii) Name a method for testing the purity of the aspirin formed.

..... **[1]**

(d) After recrystallisation, the students obtained 3.1 g of aspirin.

What value for the percentage yield does this give?

yield = ... % **[2]**

(e) Some other students make the liquid ester ethyl ethanoate.

Name the final stage in their purification of the ester.

..... **[1]**

(f) The students also carry out some tests on phenol, C_6H_5OH.

They find that it is not very soluble in water but fully dissolves when sodium hydroxide solution is added.

A student says that this shows that phenol is acidic and thus it should fizz with sodium carbonate solution.

Comment on the student's statement.

.....

.....

.....

..... **[2]**

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22 In 1875 a French chemist saw two violet lines in an emission spectrum that did not correspond to any known element. He isolated the metal responsible and named it gallium, Ga, after his country.

(a) Explain why each element has a characteristic emission spectrum.

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..... **[4]**

(b) **(i)** Complete the electron configuration of gallium, Ga.

$1s^2 2s^2 2p^6 3s^2 3p^6$ ..... **[1]**

(ii) Describe the shape of an s-orbital.

..... **[1]**

(iii) Give the charge on the cation of gallium predicted by its position in the Periodic Table.

..... **[1]**

(c) Gallium forms an anion with chlorine, $GaCl_4^-$. This is thought to have covalent bonds between a gallium atom and three chlorine atoms and a dative covalent bond from a chloride ion to the gallium atom.

(i) Draw a '*dot-and-cross*' diagram of $GaCl_4^-$.

[2]

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(ii) Name the shape of $GaCl_4^-$.

..... **[1]**

(d) Gallium has two isotopes, ^{69}Ga and ^{71}Ga.
The A_r of gallium is 69.7.

Calculate the relative abundance of ^{69}Ga as a percentage.

relative abundance of ^{69}Ga = ... % **[2]**

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23 Ethene, C_2H_4, is the simplest alkene and has a wide variety of uses in industry, especially in making polymers.

Ethene is made by the catalytic cracking of longer hydrocarbons, such as those in light naphtha.

(a) Some students are given a supply of liquid light naphtha and they need to obtain some ethene from it. They use aluminium oxide as the catalyst.

(i) Draw a labelled diagram of a suitable apparatus that they could use.

[3]

(ii) They test the gas by shaking it with some aqueous bromine.

Describe the colour **change** that they would see.

..... **[1]**

(iii) Draw the mechanism for the reaction of ethene with Br_2.

Show curly arrows, full charges and the product.

[3]

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(b) Catalytic cracking uses a heterogeneous catalyst.

(i) State how catalysts work in terms of the activation enthalpy.

.....

..... **[1]**

(ii) The students research a simple model of the function of a heterogeneous catalyst.

Name the way the hydrocarbon molecules in light naphtha first attach to the catalyst surface.

..... **[1]**

(c) Ethene can be converted to chloroethene, C_2H_3Cl.

(i) Draw the **skeletal** formula for chloroethene.

[1]

(ii) A student says that chloroethene shows *cis-trans* isomerism.

Is the student correct? Explain your answer.

.....

..... **[1]**

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24 Some students research nitrogen oxides as air pollutants.

(a) Name the main polluting effect of NO_2 in the atmosphere.

..... **[1]**

(b) The students look up some data for the experimentally measured rates of the reaction shown below.

$$2NO_2 \rightarrow 2NO + O_2$$

Their data are shown in the table below.

T **/ K**	**Relative rate**
592	1.0
604	1.4
628	3.2
650	8.0
658	10.4

Plot a graph of relative rate against temperature and use it to work out the relative rate when the temperature is 615 K.

relative rate at 615 K = ... **[3]**

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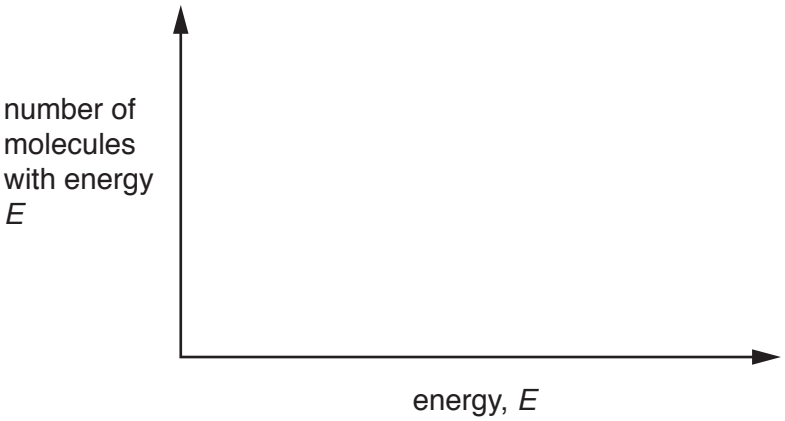
(c) Draw two Boltzmann distributions at different temperatures on the axes below.

Use your diagram to explain why the rate of reaction increases with temperature.

Label your diagram.



.....

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..... **[3]**

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(d) The students then consider the reaction that occurs in lightning flashes:

$N_2 + O_2 \rightleftharpoons 2NO$ $\Delta_r H = +180\,kJ\,mol^{-1}$ **Equation 24.1**

(i) Complete the expression for the equilibrium constant, K_c, for this reaction.

$K_c =$

[1]

(ii) A student says that, when equilibrium is reached in **equation 24.1**:

- the rates of the forward and back reactions are equal
- the concentrations of NO, O_2 and NO are equal.

Comment on these statements, giving the correct chemistry where necessary.

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..... **[2]**

(iii) Consider and **explain** the conditions of temperature and pressure that would give the greatest equilibrium yield of NO in **equation 24.1**.

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..... **[5]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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